ULTRASONOGRAPHY IN OCULAR TRAUMA

Emilija Dastevska-Djosevska

University Eye Clinic, Medical Faculty, Skopje, R. Macedonia

Corresponding Author: Emilija Gosevska Dastevska MD, Eye Clinic, School of Medicine, Ss Cyril and Methodius University, Vodnjanska 17, 1000 Skopje, Republic of Macedonia, Mobil, Tel: +389 (0)2 078 35 01 40; E-mail: egosevska@yahoo.co.uk

Abstract

Purpose: Ultrasonography is a non-invasive, simple and effective diagnostic method which enables visualization and evaluation of intraocular injury degree in cloudy eye media. The basic aim of this investigation was to find out the frequency of various types of ocular injuries using ultrasonography and to make an analysis of their frequency in relation to gender and age.

Materials and methods: This retrospective study included 182 patients hospitalized at the Clinic of Ophthalmology in Skopje due to mechanical eye trauma. The patients underwent ultrasonography on the Alcon Ultrascan Imagining System apparatus and Sonomed EZ Scan AB 5500. B scan technique was used primarily, while the A scan had a positive and correlative role.

Results: Ocular trauma was more present in males (85.2%) compared to females (14.8%). 49.5% of the patients had open, and 50.5% had closed globe injuries. The most represented age group in ocular injuries was the age ranged from 51 to 60 years. There was no significant difference between the type of mechanical injury and the age (Chi-Squares = 5.52 p = 0.47895025). Ultrasonography showed that the most frequent pathologic result, both in open and closed globe injuries, was vitreous hemorrhage.

Conclusion: Ultrasonography has an irreplaceable role in the clinical evaluation and management of ocular trauma. It showed that the most frequent finding in ocular trauma was vitreous haemorrhage, and the male gender was more frequently exposed to ocular trauma.

Key words: ultrasonography, ocular trauma, closed globe injury, open globe injury.

Introduction

Ocular trauma is one of the leading causes of unilateral morbidity and reduced visual acuity or blindness. Eye trauma represents not only a big clinical problem, but is also a socioeconomic problem [1]. Nowadays, by application of more sophisticated diagnostic methods, new surgical techniques and new rehabilitation procedures, it is possible to achieve vision retention in a great many traumatized eyes [2–4].

Echography is one of the diagnostic methods which have a very significant role in ocular traumatology. Ultrasonography (US) in ophthalmology was used for the first time by Mundt and Huges in 1956 [5, 6]. Due to reflection of the US waves from the soft eye surface, it is possible to make a differential diagnosis and evaluation of the consequences caused by the injury.

Oksala (1957) laid the foundations for the application of the linear A scan [7]. Baum and Greenwood (1958) were the first who started using the B-method in the USA [8]. Coleman, Sokollu and Purnell [6, 9] were credited with further ultrasonography expansion in ophthalmology. Standardization of ultrasound apparatus was introduced by Ossoining, which especially contributed to the exactness of this diagnostic method [6, 7]. This diagnostic method uses ultrasound (US) waves to show the ocular structures [10]. Due to reflection of the US waves from the soft eye surfaces, it is possible
to make a differential diagnosis and evaluation of the consequences caused by the injury. The ultrasound energy, being used in ophthalmology for diagnostic purposes, does not damage the eye tissues and these examinations can be repeated several times, with no consequences.

Standardized A method, or A scan (amplitude modulation) enables differentiation of one pathological process from another [11]. By this method, graphically, tissue structures and the orbit of the eye can be shown only in one direction, which means that a good inspection in the anatomic-topographic relations cannot be obtained [6].

Standardized B method or B scan (brightness modulation) is the most frequently used method in ophthalmology, which gives a two-dimensional presentation of the ultrasound finding of eye and orbit [10]. There is a possibility, at the same time, of presenting the echogram on the screen, both according to A and B method, on modern ultrasound apparatus.

Ultrasonography is a quick, simple and effective diagnostic method, which enables the making of an exact diagnosis in non-cooperative patients, vague eye media and the assessment of the degree of intraocular injuries. Its application is very simple and convenient for patients as well as for examiners, and can be used for patients of all ages [11]. By means of ultrasonography, objective and detailed information for the anatomical localization of the eye injury can be obtained.

Ultrasonography is the only non-invasive method for assessment of the rear segment of a traumatized eye in cases with vague media, and is an exceptionally significant supplement to clinical investigations. Damages caused by eye trauma of the anterior eye segment, which cannot be detected by other methods, are evaluated by means of ultrasound biomicroscopy (UBM) [12, 13].

The hypothesis of this investigation was that ultrasonography could perform a precise distinction of the lesion type in ocular injuries, such as the injury seriousness in all the anatomical parts of the eye, including the anterior and the posterior segment of the eye. The basic aim of this investigation was to find out the frequency of various types of ocular injuries by means of ultrasonography and to make an analysis of their frequency in relation to gender and age.

**Materials and Methods**

This retrospective study involved patients with mechanical eye trauma, being hospitalized at the Ophthalmology Clinic in Skopje within the period from January 2010 to December 2011, a total of 182 patients of both sexes, aged from 1 year to 85 years (mean age 38.9 ± 22.3 years).

Each patient underwent ultrasonography on Alcon Ultrascan Imagining System and Sonomed EZ Scan AB 5500* Apparatus. Primarily, B scan technique was generally used, while A scan had a positive and correlative role. Closed-lid technique was applied in all patients examined. Echographic examination was performed in all patients with a slight possible pressure of the eye globe and with sufficient contact gel to get a clear picture of the eye’s posterior segment.

Special attention was paid to the sterility of the ultrasound probe and the contact part (methylcellulose) in ultrasonography in open injuries or when the injury was closed immediately before the examination [13]. In cases of more voluminous eye rupture and prolapse of eye contents, surgical preparation was done first, followed by ultrasonography [13]. Also, before making ultrasonography of the open globe injuries, radiological investigations (x-ray of the orbits in two directions, and in some cases computerized tomography of the orbits) were made in order to detect and localize the eventual presence of any intraocular foreign body or fracture of the orbit walls. The gain of the ultrasonic apparatus was reduced to minimum in cases when abnormalities of high amplitude were to be differentiated, such as retinal detachment or the presence of an intraocular foreign body [14]. Increase of the gain to maximum was needed to easily identify changes of low amplitude, such as a haemorrhage in the corpus vitreum [14, 15].

A complete anatomic analysis of all types of ocular traumas was made by the systemic application of biometric, topographic, kinetic and quantitative characteristics of certain parts of the eye [16].
Statistical analysis of the results was made by the Statistics for Windows 7 statistical programme. The results are shown as proportions, while the significance of the results among the proportions was tested by the Chi-Square test and t-test for proportions. Level of significance was taken as p < 0.05.

**Results**

Of the total number of examinees in our investigation (N = 182), 49.5% had open globe injury, while 50.5% had closed globe injury (Table 1). The most represented age group of patients was the age above 51 years, representing 38.5% of the total number of patients, followed by the age groups: under 20 years of age (26.9%) and the group aged from 20 to 40 years (20.3%) (Table 1). The distribution difference of the type of mechanical ocular trauma presented in per cents, i.e. representation of open compared to closed globe injuries among the age groups, was not statistically significant (p > 0.05). There was no statistically significant dependence between the type of mechanical injury (closed / open) and gender (Chi-Square = 2.32; p = 0.1280739).

According to gender distribution, in the total number of mechanical eye injuries, males were presented in a greater percent with 85.2%, and females with 14.8% (Table 1). This percentile difference, being recorded between these two modalities of gender, was statistically significant (p < 0.05). Open globe injuries, in the greater percent, were represented in females, with 63.0% (compared to the total number of injured female patients than the males (Table 1). This percentile difference between the genders was statistically non-significant (p > 0.05).

The percentile difference which was registered between the injury type in the age groups according to gender representation was statistically non-significant (p > 0.05). There was no statistically significant difference between the type of mechanical injury and the age groups (Chi-Square = 5.52, p = 0.47895025).

<table>
<thead>
<tr>
<th>Age(years)</th>
<th>Total globe injury</th>
<th>Closed globe injury</th>
<th>Open globe injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10y</td>
<td>35 (19.2%)</td>
<td>23 (65.7%)</td>
<td>12 (34.3%)</td>
</tr>
<tr>
<td>11–20</td>
<td>14 (7.7%)</td>
<td>6 (42.9%)</td>
<td>8 (57.1%)</td>
</tr>
<tr>
<td>21–30</td>
<td>17 (9.3%)</td>
<td>10 (58.8%)</td>
<td>7 (41.2%)</td>
</tr>
<tr>
<td>31–40</td>
<td>20 (11.0%)</td>
<td>8 (40.0%)</td>
<td>12 (60.0%)</td>
</tr>
<tr>
<td>41–50</td>
<td>26 (14.3%)</td>
<td>12 (46.2%)</td>
<td>14 (53.8%)</td>
</tr>
<tr>
<td>51–60</td>
<td>39 (21.4%)</td>
<td>19 (48.7%)</td>
<td>20 (51.3%)</td>
</tr>
<tr>
<td>&gt; 61</td>
<td>31 (17.1%)</td>
<td>14 (45.2%)</td>
<td>17 (54.8%)</td>
</tr>
</tbody>
</table>

 Among the patients with ocular injury, 66.5% of patients were found to have ultrasonography injuries of various types of lesions, which are shown in Table 2. Vitreous haemorrhage was found in 20.9% (Table 2, Fig. 1 AB scan ultrasound of vitreous haemorrhage). Reti-
nal detachment was recorded in 4.4% (Table 2, Fig. 2 AB scan ultrasound of retinal detachment). Posterior vitreous detachment was found in 3.8% (Table 2, Fig. 3 AB scan ultrasound of posterior vitreous detachment). Endophthalmitis was registered in 3.3% (Table 2, Fig. 4 AB scan ultrasound of endophthalmitis). An intraocular body was registered in 6.6% (Table 2, Fig. 5 AB scan ultrasound of intraocular foreign body). Other ultrasonographic findings were recorded in less than 2.2% of the patients.

Table 2

<table>
<thead>
<tr>
<th>Ultrasonographic findings</th>
<th>Total number of patients N = 182 (100.0%)</th>
<th>Number of patients with open globe injury N = 90 (100.0%)</th>
<th>Number of patients with closed globe injury N = 92 (100.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endophthalmitis</td>
<td>6 (3.3%)</td>
<td>4 (4.4%)</td>
<td>2 (2.2%)</td>
</tr>
<tr>
<td>Vitreous haemorrhage</td>
<td>38 (20.9%)</td>
<td>18 (20.0%)</td>
<td>20 (21.7%)</td>
</tr>
<tr>
<td>Retinal detachment</td>
<td>8 (4.4%)</td>
<td>3 (3.3%)</td>
<td>5 (5.4%)</td>
</tr>
<tr>
<td>Posterior vitreous detachment</td>
<td>7 (3.8%)</td>
<td>4 (4.4%)</td>
<td>3 (3.3%)</td>
</tr>
<tr>
<td>Subluxatio lens crystallina</td>
<td>1 (0.5%)</td>
<td>/</td>
<td>1 (1.1%)</td>
</tr>
<tr>
<td>Luxatio lens crystallina</td>
<td>4 (2.2%)</td>
<td>1 (1.1%)</td>
<td>3 (3.3%)</td>
</tr>
<tr>
<td>Subluxatio IOL</td>
<td>1 (0.5%)</td>
<td>/</td>
<td>1 (1.1%)</td>
</tr>
<tr>
<td>Luxatio IOL</td>
<td>2 (1.1%)</td>
<td>1 (1.1%)</td>
<td>1 (1.1%)</td>
</tr>
<tr>
<td>Intraocular foreign body</td>
<td>12 (6.6%)</td>
<td>12 (13.3%)</td>
<td>/</td>
</tr>
<tr>
<td>Oedema m.luteae</td>
<td>1 (0.5%)</td>
<td>1 (1.1%)</td>
<td>/</td>
</tr>
<tr>
<td>Choroidal detachment</td>
<td>2 (1.1%)</td>
<td>1 (1.1%)</td>
<td>1 (1.1%)</td>
</tr>
</tbody>
</table>

Figure 1 – AB scan of vitreous haemorrhage
Figure 2 – AB scan of retinal detachment

Figure 3 – AB scan of posterior vitreous detachment

Figure 4 – AB scan of endophthalmitis
Discussion

In this study, the ocular trauma was more presented in the male gender with 85.2% compared to females with 14.8%. Karaman and Rai’s studies proved our finding that mechanical ocular injuries are more frequently presented in the male gender which is most probably due to the nature of their professional work and males’ activities [4, 17].

In cases with cloudy eye media such as corneal opacification, hyphaema, cataracta or vitreous opacifications, examination of the posterior eye segment is not possible [18, 19]. Traumatic cataracta can develop several hours after the injury and can also disable the ophthalmoscopic visualization of the fundus [11]. In these cases, the structural changes of the eye as well as the intraocular foreign bodies can be diagnosed and differentiated by ultrasonography.

In vitreous haemorrhage, its size (partial, subtotal or total) as well as the response are followed, i.e. the result of the treatment, by repeated echography in some time period. Organization of vitreous haemorrhages in fibrous membranes could cause retinal detachment. Involvement of the posterior eye segment has been an important factor for indication of a poor prognosis, concrete, vitreous haemorrhage, retinal detachment and endophthalmitis which increase the risk of impaired visual acuity or blindness. By visualization of the ocular anatomy, ultrasonography helps to make an exact localization of the intraocular foreign bodies.

This method helped us to perform a precise distinction among the most various types of ocular traumas, which is shown in Table 2. Vitreous haemorrhage was the most frequent finding in ultrasonography examination, it was found in 20.9% of our patients. By ultrasonography, the volume and extension of the blood mass could be followed and the results of medication evaluated, i.e. by following the course of its reabsorption. In our study, retinal detachment was recorded in 4.4% of the patients, which ultrasonographically was shown as a highly echogenic movable membrane with insertion of retina in the optical nerve and in front of the ora serata. On scan AB, a high cog in the corpus vitreum is seen, which reaches the height of the sclera and is in front of the cogs of the sclera and orbit (Fig. 2 AB scan ultrasound of retinal detachment).

Posterior vitreous detachment was present in 3.8% in our study. On scan B, it is shown as a thin, movable, continuous membrane, which has no insertion on the optical nerve, and on scan A as a high cog (Fig. 3 AB scan ultrasound of posterior vitreous detachment). In our study, endophthalmitis was present in 3.3%. Inflammatory contents of the corpus vitreum in endophthalmitis is shown on B scan with diffuse echo signals, ranging from low to medium echogenicity and a thickened chorio-retinal layer. On A scan higher cogs of cellular and fibrinous exudation can be shown (Fig. 4 AB scan ultrasound of endophthalmitis).

An intraocular foreign body was present in 6.6%. Thanks to ultrasonography, more detailed information could be gained for the exact localization of the intraocular foreign body, its
magnetic characteristics, the best method for its extraction, etc. By this noninvasive method a clear picture of the damages which occurred through its path in the eye and the orbit could be gained. On A scan, it is shown as a maximally high cog, which causes strong deflection from the basic line, while on B scan as a very intensive echo signal, a bright shadow, respectively. The echogenicity of the foreign body depends on its surface: the smoother, the higher echogenicity. By means of kinetic ultrasonography it can be verified whether the intrabulbar foreign body is free in the corpus vitreum or is fixed in globe tissue. Topographic echography enables its localization in the eye globe (Fig. 5 AB scan ultrasound of intraocular foreign body).

In our study, lens crystallina dislocation or IOL (subluxation, luxation) gave the following ultrasonographic findings for this pathology: subluxatio lens crystallina 0.5%, luxatio lens crystallina 2.2%, subluxatio IOL 0.5%, luxatio IOL 1.1%. Luxatio of lens crystallina in the corpus vitreum is movable during eye movement and on A scan it is seen as a high cog of the lens front capsula (Fig. 6 AB scan ultrasound of luxatio lens crystallina). Luxatio of IOL gives a reverberation of the echographic wave contrary to the natural lens.

Figure 6 – AB scan of luxatio lens crystallina

Choroidal detachment was present in 1.1%. On B scan, it is shown as a semiball which has no insertion on the optical nerve and orra serata, and has a smaller reflection in relation to retinal detachment.

In many worldwide studies it has been proved that ultrasonography is a key method in differential diagnosis for various pathological lesions in eye injuries [10, 11, 13–15].

In McNicholas and Kwong’s study and in ours as well, vitreous haemorrhage appeared as the most frequent ultrasonographic finding [11, 20].

Our ultrasonographic findings have an important role in planning surgical intervention in open globe injuries, especially in the direction to approach vitreous haemorrhages and the remnants of intraocular foreign bodies [21].

**Conclusion**

The results from our study show that the male gender was more frequently exposed to ocular traumas (85.2%) compared to the female gender (14.8%); there was no significant difference (p > 0.05) between the representation of closed (50.5%) and open globe injuries (49.5%). The most represented age group in ocular injuries was the age ranging from 51 to 60 years; and the most frequent finding, independently of the injury type, was vitreous haemorrhage.

Echography is a safe, effective and simple method for the detection and differentiation of various traumatic intraocular pathologies. One can evaluate the effects of the administered therapy, as well as plan further surgical treatment if it is necessary. So, this comparative
method has a very important role in the clinical evaluation and management of ocular trauma.

REFERENCES


при отворените и при затворените очни повреди) е крвавење во corpus vitreum.

Заклучок: Ултрасонографијата има незаменлива улога во клиничката процена и менаџирањето на окуларната траума. Таа покажа дека најчест наод каде окуларните трауми е крвавење во corpus vitreum, при што мажкиот пол е почест изложен на окуларни трауми.

Ключни зборови: ултрасонографија, окуларна траума, отворена очна повреда, затворена очна повреда.